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FEDERAL EMERGENCY MANAGEMENT AGENCY

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Maintenance Manual Emergency Generators



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MAINTENANCE MANUAL

EMERGENCY GENERATORS

**Federal Emergency
Management Agency**

Maintenance Manual Emergency Generators

Introduction

The purpose of this manual is to guide you on how to maintain emergency generators. The information in this manual is only a **supplement** to the recommended maintenance information supplied in the service manuals provided by the manufacturers of the equipment. **Always follow the maintenance procedures provided in the manufacturer's manuals.** This manual will help you understand why maintenance is necessary. This will also be helpful if the manufacturer's maintenance manuals are not immediately available.

Description of Emergency Generators

Emergency power generators are employed as an alternate power source if normal commercial power is not available. These generators supply energy to maintain and operate essential equipment. Since they are rarely used except in an emergency, power generators may not be inspected or maintained at the same level as other equipment.

There are three ways of transferring power demands from your normal sources to an emergency system. They are:

1) Manual Transfer. Used when minor power outages can be tolerated. Requires personnel to crank up emergency generators after outage has occurred.

2) Automatic Transfer. Used when outages of a very short duration can be tolerated. No personnel involved; time lag caused by response time of emergency generators to power failure.

3) No-Break Power. Used when outages cannot be tolerated. Three options available--

a) Inertia type. Consists of a motor, a generator, and a fly-wheel (all mounted on one shaft), an engine, and a clutch arranged between the engine and motor-generator-flywheel system. When main power fails, sensing relays start the engine which in turn drives the generator, creating energy.

b) Electric type. Consists of AC and DC motors, an AC generator, and a fly-wheel all mounted on one shaft. Under normal conditions, usual power sources operate AC motor and generator. When this power source fails, sensing relays connect battery to the DC motor, which then drives the AC generator.

c) Static Uninterruptible Power system. Consists of a rectifier charger, a battery and an inverter. During normal operating conditions, AC power is converted to DC power by the rectifier charger and fed to the inverter for conversion to AC to run on-line equipment. In an emergency, the inverter draws power from batteries to operate essential equipment.

Preventive Maintenance

To ensure that your emergency generators work in an emergency, you should develop a program where you **regularly check the equipment to spot small troubles before they become big problems**. A program of periodic maintenance checks prevent serious problems from suddenly happening.

Routinely clean all the units. Check for frayed connections and loose bolts and parts. These checks are not normally mentioned in manufacturer's manuals, but can prevent more serious problems.

Equipment and Spare Parts

Only ordinary mechanical and electrical tools are needed to perform most maintenance on this equipment.

Maintain a list of spare parts. The following table gives you an example of a list of spare parts for a diesel generator.

Spare Parts: Diesel Generator

<u>Names of parts</u>	<u>Quantity</u>
inlet & exhaust valves with retainers & keepers	1
inlet & exhaust valve springs	1
inlet & exhaust valve guides	1
inlet & exhaust valve seat inserts	1
scavenging valve assembly per cylinder	2
fuel injection nozzle holder assembly	1
injection nozzle valve assembly & spray tip	2
fuel-pump assembly	1
multiplunger fuel pump	1
fuel injection pump plunger & barrel assembly	2
fuel injection high-pressure discharge tubes	1
cylinder head gaskets or ring gaskets	2

Spare Parts: Diesel Generator (cont.)

<u>Names of parts</u>	<u>Quantity</u>
cylinder liner water seal rings	3
piston compression & oil control rings	1
wrist pin bearing shells or bushings	1
camshaft bearing or bearing shells	1
idler gear shaft bearing	1
connecting rod bearing shell	1
crankshaft main bearing shell	1
crankshaft thrust bearing shell	1
filter elements	2 sets
springs	1 set
gaskets	2 sets
exhaust thermocouples	1
thermometers	1
pressure gauges	1
outboard bearing or shell	1

Safety

Follow safety precautions outlined in maintenance manuals supplied by the manufacturer. The circuits of some of this equipment may contain high levels of voltage that are potentially dangerous. Only a qualified electronics technician should attempt to repair any serious electrical problems.

Inspection

Develop an inspection schedule to test your equipment. Operate all equipment at least once a month under load to detect problems before an emergency. The following schedules provide a general guide; develop an inspection schedule and maintain an operating and maintenance log to fit the equipment on hand and the use that this equipment receives over the course of a year.

Hourly Maintenance Checks (under operating conditions)

1) Check engine pressure, fluid levels, and fuel pump rack positions.

Daily Maintenance Checks (under operating conditions)

1) Keep a record of total operating hours, kw-hours produced, and fuel and lube oil consumed. Note condition of station batteries. Keep track of the amount of fuel and lube oil available in storage. Note the appearance of the engine exhaust.

2) Check water, lube and fuel oil, and air systems for leaks. Open vents in these systems to release entrapped air.

3) Examine high pressure fuel injection systems for leaks. Wear goggles.

4) Replenish lube oil with same oil, as necessary.

5) Open every indicator cock consecutively and leave open for three power strokes.

6) Check water and anti-freeze in cooling-water surge tank.

7) Test alarm system with test switch.

8) Drain water and sediment from starting air and fuel tanks.

9) Lubricate governor linkage and other wear parts.

Maintenance Checks after 150 hours of operation

1) Inspect crankcase for loose bolts, oil, water, and fuel leaks.

2) Examine cylinder head valve gear for proper lubrication.

3) Check water pump glands.

4) Check lubricating oil for water or fuel oil contamination.

5) Inspect air intake filter screens or oil bath filter sump.

Clean if necessary.

6) Examine radiators and radiator fans. Clean if necessary.

Maintenance Checks after 700 hours of operation

1) Check compression & firing pressures. Record results in daily log.

2) Examine inlet & exhaust valves as well as injector-valve tappet clearance. Adjust, if necessary.

3) Note operation of camshaft, cams, and other valve-gear components for proper lubrication.

4) Test viscosity of crankcase lube oil.

5) Check oil for moisture and acids

6) Check the governor drive gear for excessive backlash.

Maintenance Checks after 700 hours of operation (cont.)

- 7) Test the overspeed rpm during a shutdown.
- 8) Check crankshaft deflection, crankshaft thrust clearance, and power takeoff alignment, including tightness of fly-wheel bolts.
- 9) Examine all belts.
- 10) Evaluate pressure differential through lube oil filter.

Maintenance Checks after 4500 hours of operation

- 1) Check foundation bolt nuts and tie rods for tightness.
- 2) For two-cycle engines, check inlet and exhaust ports for excessive carbon formation around the edges of the ports.
- 3) Remove and clean thermocouples and check pyrometer selector switch and junction boxes for proper electrical connections.
- 4) Look for scale in engine cooling water jackets.

Maintenance Checks after 8000 hours of operation

- 1) Establish wear rates for all internal moving parts. Remove cylinder head, piston, and connecting rod of the engine.

Measure the following:

- a) crank & piston pins for size and roundness, and
- b) inside diameter of connecting rod bearings.

Inspect the following:

- a) bearing surfaces for evidence of dirt,
- b) inside diameter of the wristpin bearing,
- c) cylinder liner bore,
- d) compression rings groove clearance,
- e) oil control or scraper rings (do not remove from the piston),
- f) intake and exhaust valve seats,
- g) valve springs,
- h) injection nozzle, and
- i) starting air valve.

- 2) Drain the governor oil, and flush with kerosene or light grade fuel oil. Refill with new governor oil.
- 3) Check fuel regulating linkage for binding.
- 4) Examine calibration & operation of alarm and protective devices.
- 5) Calibrate the pressure and temperature measuring devices.
- 6) Examine stored diesel and gasoline to determine its freshness. Replace with new as necessary.

Maintenance Checks after 8000 hours of operation (cont.)

- 6) Check the condition of all gears and shafting.**
- 7) Remove the cylinder head of starting valve air compressor, and inspect condition of valves.**
- 8) Examine the internal condition of the lube oil cooler.**
- 9) Inspect the turbocharger air impeller.**

Corrective Maintenance: Troubleshooting

Some equipment malfunctions during inspection or use of the power generators. These malfunctions may be heralded by unusual sounds (changes in pitch or intensity of noise), abnormal vibrations, and misalignment of components. Develop a sense of the normal operating behavior of your generators; it is essential to spotting internal mechanical problems that require further investigation. Keep track of readings provided by pressure and temperature gauges as well as volt, ampere, and watt meters. Performance can also be judged by the appearance of an engine's exhaust. Dark exhaust indicates poor combustion; white exhaust indicates the presence of water; blue exhaust suggests excess lube oil. Pinpoint the problem using these clues and dismantle the specific components to locate and resolve the trouble.

PLEASE NOTE: This manual does not attempt to list all possible malfunctions that could occur nor can we suggest all possible remedies. Consult the manufacturer's manuals.